DIMENSIONS NBS

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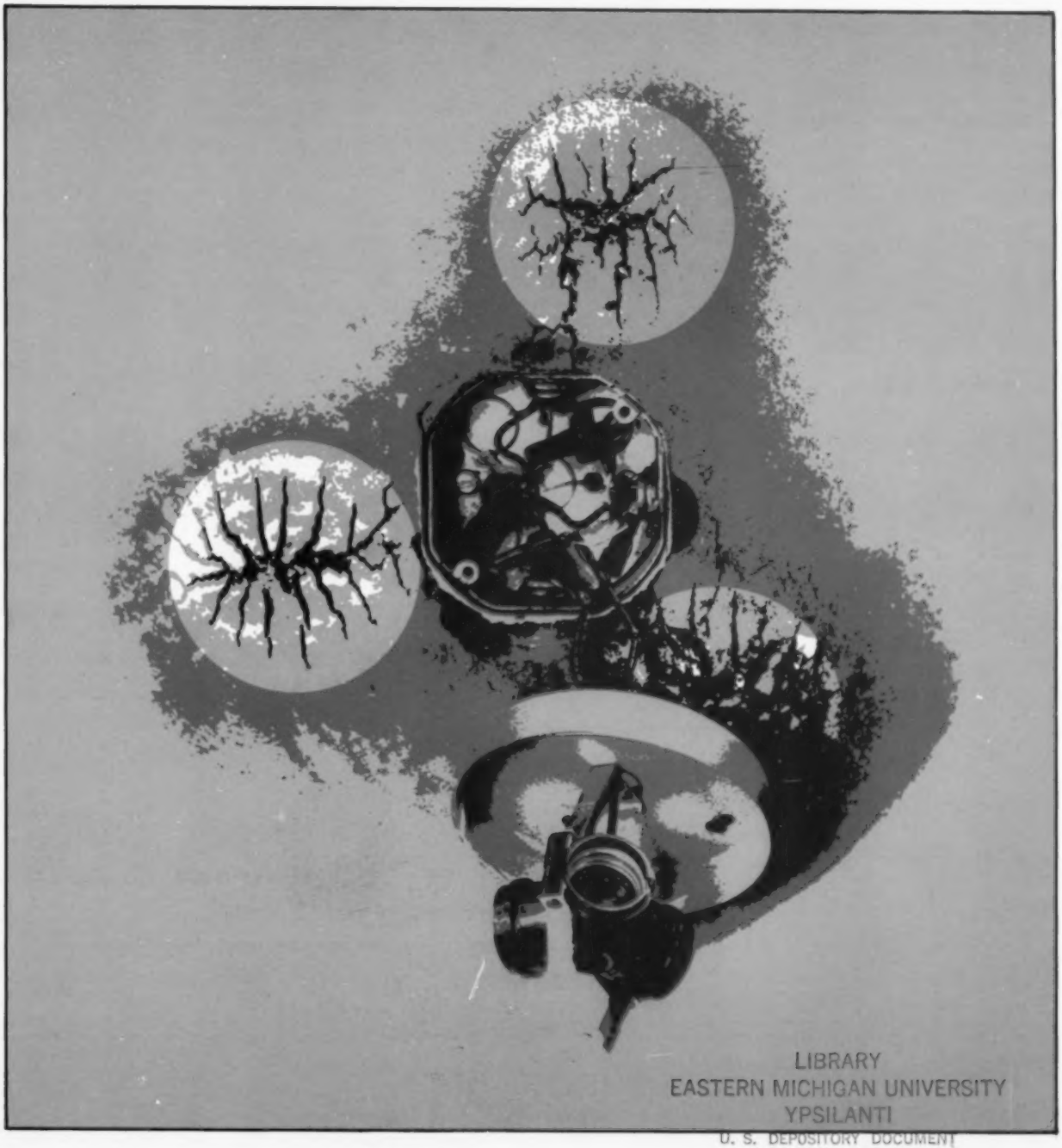

SAFETY FIRST. See page 12.

COMMENT

EFFECTIVE COMPUTER NETWORKING

The Institute for Computer Sciences and Technology (ICST) program for computer based office systems, described in this issue of DIMENSIONS, is one of three major components of ICST's computer networking program. The other two components are: computer network protocols to enable the effective exchange of information among computers as well as between terminals and computers; and local area networks to facilitate the connection of devices to local area networks and the interconnection of these networks to national and international computer networks.

The goal of the networking program is to enable Federal agencies to use distributed computing effectively and to help them select compatible components for distributed systems on the basis of cost and performance. This program is carried out under ICST's Brooks Act mandate: to develop automatic data processing (ADP) standards and guidelines for Federal Government agencies, to provide technical assistance on a reimbursable basis to agencies for the solution of ADP-related problems, and to conduct computer research in support of standards development and agency assistance activities.

The capability to structure a network using off-the-shelf components and commercially available facilities would be extremely beneficial to industry and governments. Networking technology for interconnecting a wide variety of computers, terminals, and special purpose systems is rapidly evolving. National and international public data networks are developing and expanding. Special technologies for local area networks are now available. Special purpose networks, such as computer-based office systems and laboratory data collection and analysis systems, are also available.

In some cases, manufacturers are developing network architectures that will make their systems internally compatible. However, in many cases incompatibilities in architecture obstruct interconnection of systems and prevent users from exploiting the full potential of networks and distributed systems. It is possible that, once a network architecture or service is selected, an organization cannot take advantage of the solution most cost-effective to new requirements due to problems of incompatibility.

The ICST networking program is designed to meet Federal Government needs for using networking technology effectively and for transmitting information both between local and special purpose systems and through national and international networks. A primary objective is to provide standards for computer networks so that each organization need not define a unique, and often costly, solution to networking problems. The program is carried out in close cooperation with voluntary standards activities and with the manufacturers and vendors of systems, as well as with agencies of the Federal Government.

Several important products will be issued this year. One is the guidance on requirements analysis for office automation systems, discussed in the articie on Federal office automation in this issue. In the network protocols program we expect to complete work on transport and session control protocols which encompass functions referenced in the transport control layer and session control layer of the International Organization for Standardization's *Reference Model for Open Systems Interconnections*. Our first product in the local area networking program will be a guideline to assist Federal agencies in specifying, evaluating, and selecting local networks.

Organizations and individuals wishing more information about these programs are invited to write to me at the address below.

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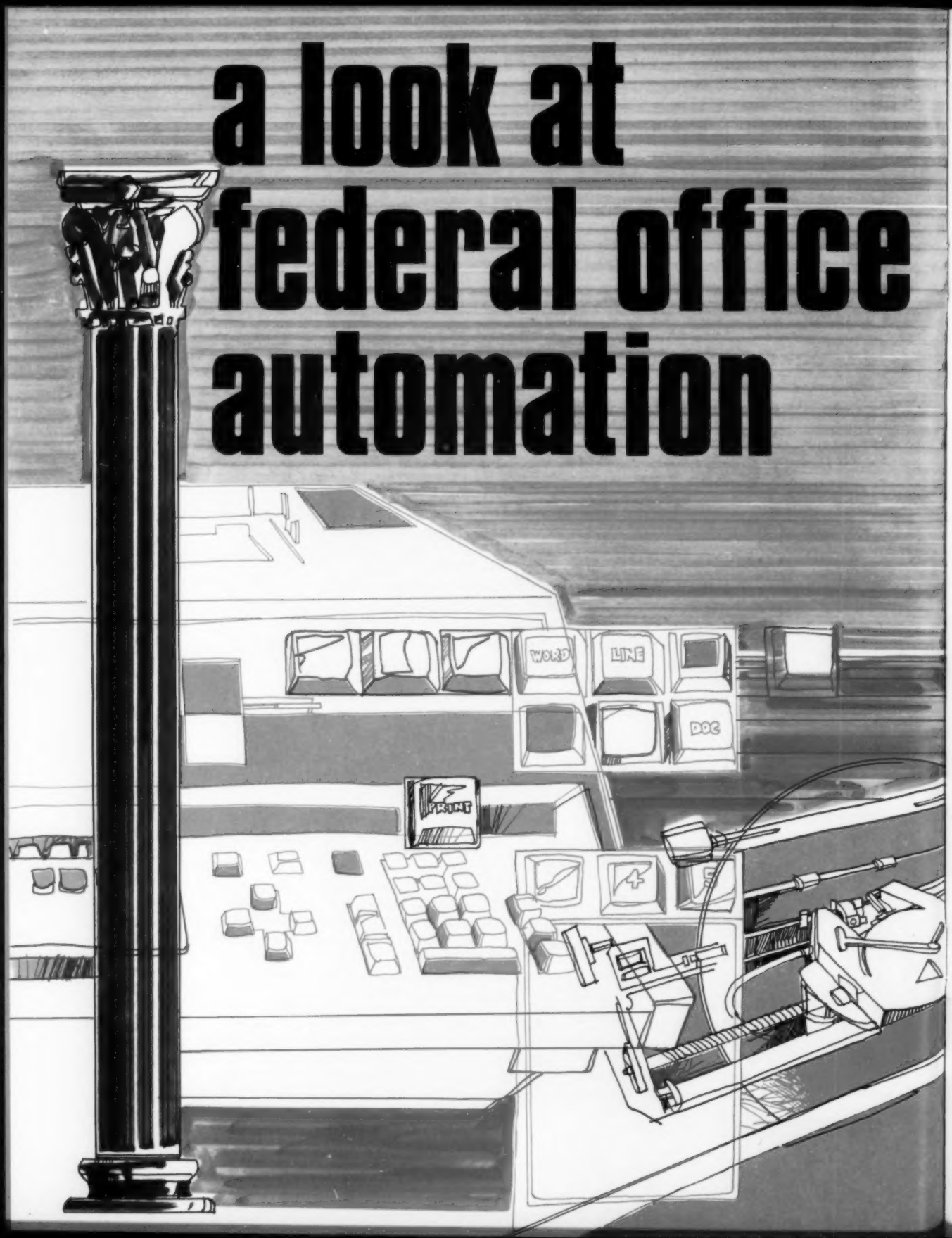
a look at federal office automation



by Shirley Radack

An article in *Computerworld* in July 1980 described the use of word processing equipment by the White House staff. One of President Carter's speech writers was quoted as saying that word processors were "wonderful machines, absolutely spectacular." According to the article, the average number of hours that White House speech writers and secretaries worked each week was reduced from 70 to 50 as a result of the equipment.

• In a 1979 study* of Federal agency use of word processing, the General Accounting Office found that a lack of management control over the acquisition and use of word processing equipment was costing the Environmental Protection Agency millions of dollars. It claimed that much of EPA's word processing equipment was misused or not used at all.

These two accounts, while perhaps not typical of the Federal Government, point up some of the issues that concern Federal managers today—planning for and using new technology, managing resources effectively, and improving workforce productivity.

Federal agencies are becoming increasingly dependent on information technology to carry out Government programs. Use of technology makes it possible to improve workforce productivity, to provide better services to the public, and at the same time to keep costs under control. The Federal Government, with its large office workforce, quite naturally, has become a larger user of office automation technology. The GAO estimates that the Federal Government spent about $80 million in fiscal year 1977 for word processing equipment, and that these costs will increase to $200 million by 1982. The International Data Corporation forecasts that, by 1985, more than 170,000 electronic typewriters and word processors, valued at almost $2 billion, will be installed in Federal agencies.

The Federal Government's experiences with office automation have been limited primarily to the use of word processors. Some agencies, such as the Departments of Army and Air Force, have completed studies of their office automation efforts and have demonstrated productivity improvements. However, the General Accounting Office report says that ". . . most agencies can neither demonstrate that they have increased their productivity nor that their word processing systems are, in fact, cost effective." GAO claims that agencies have not conducted the necessary analyses: feasibility studies, including the gathering of baseline productivity data; cost-benefit studies; planning studies of system effects or personnel; and post-installation reviews.

However, the integrated Federal office of the future will require more than just word processing equipment to provide the environment that will support clerical, administrative, managerial, and technical workers. Word processing systems interconnected with computers, with electronic message and teleconferencing capabilities, and with facsimile equipment and global networks could provide that environment.

Consider the complexities of achieving these integrated systems within the Federal Government. First of all, Federal agencies use a wide variety of computer and office equipment from 20 different manufacturers of computer systems, 100 different manufacturers of office systems, and 100 different manufacturers of terminals.

In addition, some agencies are experimenting with local data networks that link their computer and communications facilities over a limited geographic area. Agencies also use links to public data networks. Incompatible interfaces, formats, user procedures, and communications protocols prevent these systems and components from being interconnected for more efficient use of resources. The user needs standards of compatibility to avoid large expenditures for duplicate systems and facilities and to make the most effective use of existing facilities.

Standards not only make it possible to procure equipment competitively, as the Federal Government is required to do, but assure that systems and components can be interconnected and that they will work together properly. Standards help users plan for and carry out conversions from one system to another and from existing technology to advanced technology. Further, standards make valuable skills transferable from one system to another and from one agency to another. However, very few standards of compatibility needed by the user to link systems together exist today.

The Institute for Computer Sciences and Technology (ICST) of the National Bureau of Standards, through its Federal Automatic Data Processing (ADP) standards program, is addressing some of the user

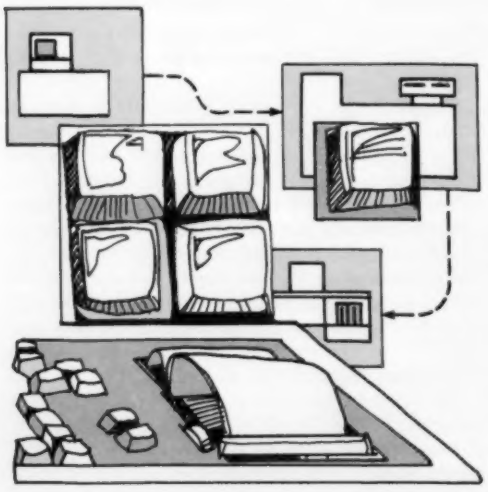
*U.S. General Accounting Office, April 6, 1979; FGSMD-79-17.

Radack is in the Office of the Director, NBS Institute for Computer Sciences and Technology.

needs—to achieve better acquisition, management, and use of computer, office system, and network resources. ICST is responsible, under the Brooks Act, for developing Federal ADP standards (to be approved by the Secretary of Commerce), providing technical assistance to Federal agencies, and supporting computer science research.

For the past 2 years, ICST has been focusing on ADP standards development activity, specifically on standards and guidelines that are needed by Federal agencies to address their high priority ADP problems. The work has been divided into seven areas of concentration: high-level programming languages, software quality, computer system and network interfaces, database management systems, computer security, system selection and evaluation, and data elements.

In the computer system and network interface area, or "family" of standards, are included standards and guidelines for computer-based office systems. The computer system and network interface work addresses the problems of incompatibility that were mentioned earlier. ICST's goal is to provide agencies with the measures needed to create distributed computing systems and to procure the constituent components of these systems competitively on cost and performance bases. This work is coordinated with voluntary standards groups vendors, and other Federal agencies to assure that the Government's standards and guidelines are compatible with industry trends and with Federal needs.



In the computer-based office systems area, ICST will develop standards to improve communications and integration and to insure document interchange between automated offices. Plans include standards for message and file formats, text editing and document formatting commands, and message processing commands:

- A computer-based message system will enable users on one system to communicate with users of other such systems.
- A Flexible Disk File Format Standard will establish common file formatting and labelling conventions for flexible disks. This standard will enable disks to be interchanged between different systems.
- A Text Editing Directives Standard will establish a minimum common set of user directives or commands for text editing systems or services.
- A Text Formatting Directives Standard will provide a minimum common set of user directives or commands for text formatting systems or services.
- A Message Processing Directives Standard will establish a common set of user directives or commands for computer-based message systems.

The latter three standards will provide for a minimum level of functionality for text editing, text formatting, and message processing systems and will aid users in switching from one text editing, formatting, or message system to another.

ICST is also planning several guidelines to aid Federal managers and users in planning for, selecting, and evaluating computer-based office systems. The first of these guides has been completed. The methodology described in the guide is expected to help agencies determine the feasibility of implementing office automation systems.

Guidance on Requirements Analysis for Office Automation Systems was developed to help Federal agencies conduct thorough requirements analyses and procurement justifications for office automation systems. Unlike previous studies, which focused on the use of word processing to aid clerical and secretarial staff members, this guide recommends a process to measure benefits for professional staff members as well. Since total office productivity will be increasingly important, studies of office automation must go beyond word processing and include a wide range of technologies that affect office paperwork from the input of ideas through the distribution of written communications.

The recommended methodology involves the collection of productivity data relating directly to the workload of both professional and support staffs.

Data are collected through interviews, questionnaires, and observations by a team selected to carry out the study.

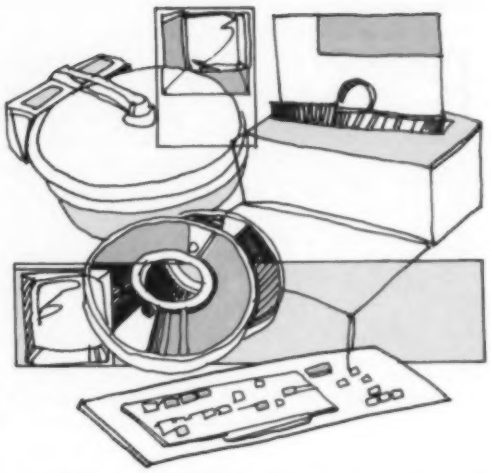
There are five key steps in the recommended analysis process: determining baseline office productivity; designing the office automation system; developing functional specifications; assessing the cost justification for implementing the office automation system; and conducting post-implementation audits.

To begin its analysis, the study team identifies all products within the organization and narrows this list to a set of "key" products that are tracked through the organization by phase of preparation (input, production, output, and distribution). A "product" is defined as a regularly produced output, either in written form or as a service, contributed by one or more individuals, and requiring significant amounts of time and cost. Times and costs associated with producing the key products are detailed. An office work analysis is also performed to collect data on the total range of daily activities performed by all office personnel. The data from both collection efforts are analyzed and used to create a "baseline" profile of existing office productivity.

Using baseline results, the study team develops system requirements to achieve a set of productivity improvement goals. These requirements are translations of user needs and organizational objectives into quantifiable terms, and they reflect expected changes to the baseline office environment when the office automation system is in place. The system requirements become the basis for developing a macro level "system design model" that incorporates organizational, procedural, and/or technological modifications to improve baseline product preparation. Effects of the expected productivity improvements of each modifications are then quantified, and new key product preparation processes are developed.

The study team next prepares functional specifications for each equipment type to be installed and identifies desired features and capabilities to permit competitive bidding. The team also constructs a representative equipment configuration and determines the estimated average costs of the components for use in preparing the cost justification assessment.

The cost justification assessment is the most critical aspect of the study methodology in that it considers the practicality of implementing the office automation system. Key factors in this assessment include the baseline profile results, the estimated



costs for implementing the automated system, and the projected productivity improvement cost savings associated with implementation. The study team prepares cost projections to reflect two conditions, retaining the baseline manual system and implementing the office automation system. These projections are compared to ascertain whether or not it is practical and justifiable to proceed with full or partial system implementation.

Post-implementation audits of office automation systems are prepared to compare expected with actual productivity improvements. The audit results will indicate the degree of productivity improvement achieved and will identify potential areas for further enhancements.

While the suggested methodology can help in measuring productivity improvements to be achieved through implementation of office automation systems, there is no guarantee that such improvements will actually accrue or that the time saved will be used productively. Managers must recognize that productivity improvements are improvements only if professional and support staff direct resulting surplus time to other activities that contribute to their organization's missions.

As this and other guides are made available to Federal agencies, ICST expects more organizations to be able to plan for and justify the use of advanced technology. Efforts to do so will not only make the work environment more productive (benefitting the U.S. taxpayer), but will also provide better public services and a more efficient environment for the individual worker. □

SAFER PRACTICE MAKES PERFECT

by Keming Kuo

Willow Island investigations.

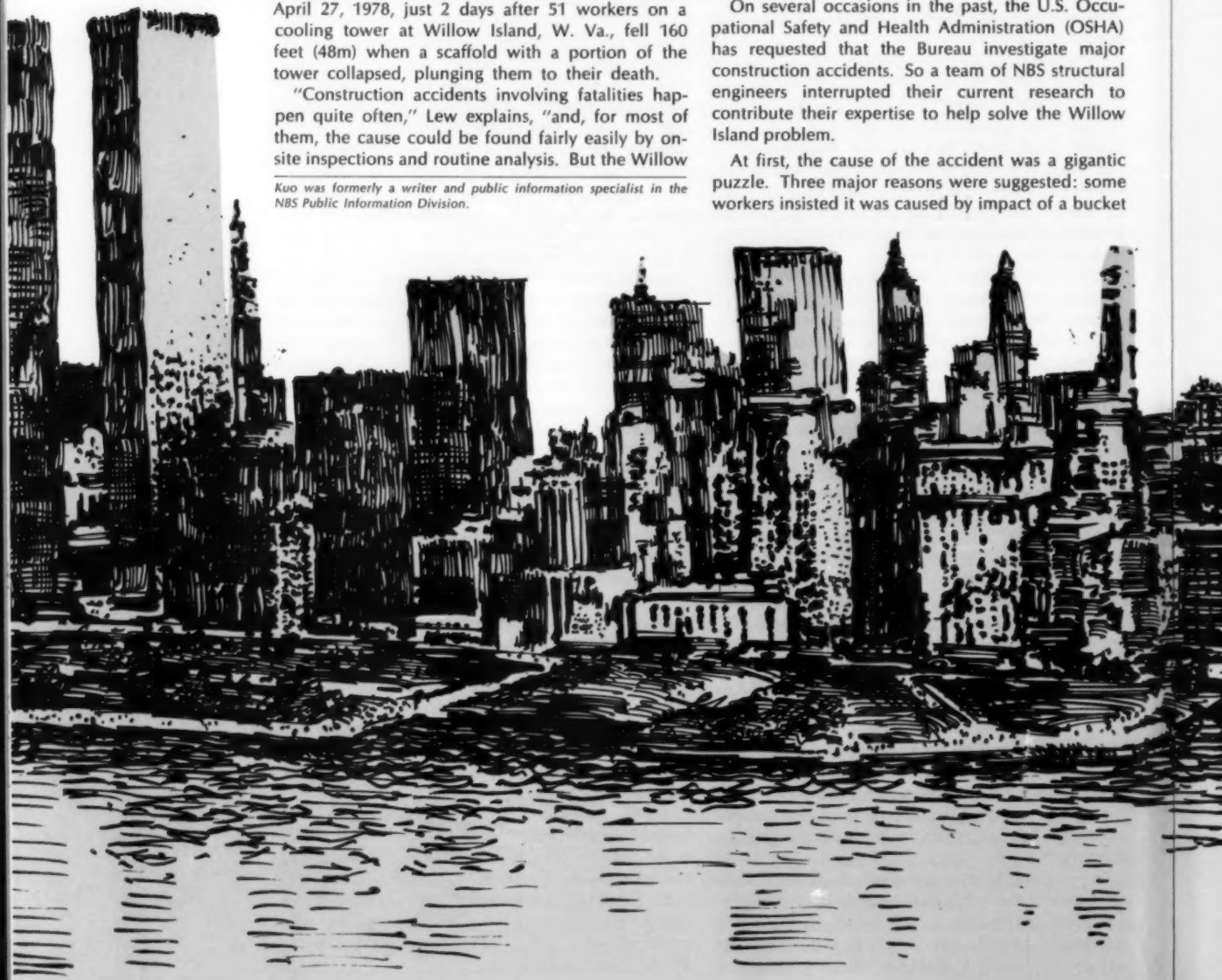
Perched in a steel bucket atop a tall, tower crane, Dr. H. S. Lew had a clear overview of the devastation below. Within the massive cylinder, shaped like a giant hourglass, lumber and twisted metal were entwined like spaghetti. It was April 27, 1978, just 2 days after 51 workers on a cooling tower at Willow Island, W. Va., fell 160 feet (48m) when a scaffold with a portion of the tower collapsed, plunging them to their death.

"Construction accidents involving fatalities happen quite often," Lew explains, "and, for most of them, the cause could be found fairly easily by on-site inspections and routine analysis. But the Willow Island case was different, and there was a need for a major, comprehensive investigation requiring multi-disciplinary approach—something that the Bureau of Standards is asked to provide when construction accidents of extraordinary magnitude and complexity occur. You might say that we get the worst problem cases."

Kuo was formerly a writer and public information specialist in the NBS Public Information Division.

On several occasions in the past, the U.S. Occupational Safety and Health Administration (OSHA) has requested that the Bureau investigate major construction accidents. So a team of NBS structural engineers interrupted their current research to contribute their expertise to help solve the Willow Island problem.

At first, the cause of the accident was a gigantic puzzle. Three major reasons were suggested: some workers insisted it was caused by impact of a bucket



NBS STRUCTURAL SAFETY STUDIES

of concrete which swung into a hoisting frame, others blamed the scaffolding, and some wondered about the concrete in the tower itself.

"What surprised me—in that first view of the scene—was that the break was so clean, so smooth," recalls Lew. "It was very difficult to visualize what happened since everything had collapsed and was strewn on the ground. It didn't look as if the concrete had failed—there were no large concrete chunks; rather there were just small pieces. The height of the drop from the top of the tower was such that the concrete was pulverized into small fragments by the fall."

An OSHA team of about a dozen inspectors interviewed witnesses, but the accident was "so swift," Lew says, "that, at first, no one had a clearcut idea of what components had failed. It was difficult afterward to identify what was what."

The preliminary reports from some witnesses, that a swinging bucket of concrete caused the accident, proved untrue. "A lot of what people said just didn't jibe with the evidence we found," Lew explains. "Only six people had a chance to see what happened, but we think they had a hard time seeing anything from under the platform."

Lew's first visit was just for a day. He made three more visits and brought four more NBS specialists with him. They also visited another site where the same contractor had successfully built a cooling tower. Other researchers at the Bureau began analyzing the material. Months of examination and testing involved other Bureau researchers, from chemists to computer specialists. In addition to exhaustive lab tests, mathematical models of the tower were prepared and analyzed by computer.

With the fact finding completed, Lew and his team reviewed a variety of best-case hypotheses for the cause (or causes) of the Willow Island accident.

"After a step-by-step analysis," Lew says, "we

realized that it had to be the concrete—the concrete had not cured enough to support the construction loads including workers and equipment." That curing process was crucial, because the formwork and scaffolding were anchored solely in the recently poured top layers of the concrete shell. The Bureau's findings are described in detail in a 1979 report.

Another NBS report recently published* methodically examines the possibilities of what might have happened had the workers used different procedures. "It's a number of 'what if's . . .'," Lew explains. A major conclusion in the report regarding the concrete used in construction suggests that a compressive strength of 1000 pounds per square inch (psi) (7000 kPa) would have been necessary—under the circumstances at the time of the accident—to avoid the failure of the concrete of the previous day's pour. Instead, the strength of the concrete was estimated to have been 220 psi (1500 kPa).

Lew says that the fatal accident was not the sole reason for increased work by the Bureau in the area of concrete construction. "But it helped. Willow Island helped the public understand how important this research is, much as the 1971 San Fernando (Calif.) earthquake prompted an increased effort in Federal earthquake research."

Lew's current research effort is directed toward the study of concrete strength—especially in early stages after preparation. "We do not understand fully at present those factors which affect the gain in strength of concrete at early ages and without this knowledge we can't estimate the safety factor," Lew says. "We also need to know how to determine in-place strength of young concrete."

Lew is confident that NBS will undoubtedly help solve these construction riddles with the multidisciplinary approach the Bureau brings to construction safety research. "Our staff and research facilities for construction safety are unique," he continues, proudly. "We have a diverse expertise under one roof."

The bonding element.

Cement, the bonding element for concrete, mixed with water, has not been overlooked as a subject of research at NBS. Researchers here have developed a preliminary mathematical model for the hydration of tricalcium silicate (the major constituent of most Portland cements). This is the first step toward a mathematical model for predicting the performance, strength, and durability of concrete based on its composition. Developed by NBS engineer Dr. James R. Clifton and Dr. James Pommersheim, a visiting scholar from Bucknell University, the model should have a major impact on predictions of service life of concrete and eventually should prompt energy and material conservation in the cement and concrete industries.

Most of us recall only major construction-related accidents, such as the 1978 Willow Island tragedy, but more than 200 workers lost their lives in shallow trenches that same year and additional deaths resulted from the collapse of deep excavations. Our country's 4 million construction workers comprise

**Lew, H. S., and Fattal, S. G., Analysis of Construction Conditions Affecting the Structural Response of the Cooling Tower at Willow Island, West Virginia, NBSIR 80-2010, for sale by the National Technical Information Service, Springfield, VA 22161, $6; order by #PB 80-222631.*

"Liquid" sand

In one NBS experiment on soil liquefaction, small-scale periodic vibrations are induced on a new laboratory instrument known as a resonant column apparatus. A sample of water-saturated sand is contained in a coffee cup-sized membrane and surrounded by electro-magnetic coils which create the vibrations. The electro-magnetic fields set up torsional motion not unlike that of a washing machine agitator twisting and churning a load of clothes. An acrylic plastic cylinder encloses the sample-coil assembly and contains water a third of the way up the meter-long column. The buildup of internal water pressure, which initiates the liquefaction process, is measured carefully by the apparatus during the experiment.

Normally, the effects of the vibrations are imperceptible. But when the power input is set at high levels, the internal water pressure increases and the sagging of sand within the thin testing membrane is plainly visible, with water flowing toward the top of the sample. The buildup of water pressure provides Chung and his colleagues with insights into the sand behavior leading to liquefaction.

Using the same laboratory arrangement, NBS researchers are also studying whether sand already subjected to seismic effects reacts differently and the magnitude of that difference compared to new, unstressed samples.

NBS geotechnical engineer Riley M. Chung, adjusts digital monitors for the resonant column apparatus which is used to simulate earthquake forces.

only 6 percent of the Nation's industrial work force, but they suffer 20 percent of the fatalities and 10 percent of all job-related injuries.

In another construction safety research effort, NBS engineers have developed a series of technical recommendations designed to make trenching and excavation work safer. The researchers have developed a way for supervisory construction personnel to design the shoring and determine the steepest allowable slopes for utility trenches or shallow excavations. The method has been put in the format of a recommended standard practice.

Other safety issues—excavating and trenching.

The recommended technical provisions, which apply to all excavations more than 5 feet (1.5m) wide and less than 20 feet (6m) deep (except those in unfractured rock), cover sloping, shoring systems, sheeting, special provisions for intersecting trenches, sloping backfill, excavation below the bottom of the sheeting, and restrictions on placement of equipment and material.

The most important element of the NBS recommended practice is the soil classification system. Two alternative approaches are recommended for consideration by OSHA; NBS suggests that one be selected for inclusion in a future trenching standard. Bureau researchers also studied the lumber used in bracing trenches, surveyed contractors' trenching-shoring practices, and examined trench-safety procedures. The project, sponsored by OSHA and the National Institute of Occupational Safety and Health (NIOSH), is aimed at reducing the numerous deaths and injuries that occur each year as a result of excavation cave-ins.

Earthquakes and construction safety.

It has been said that an earthquake makes a caricature of a building.

Experts have forecast that a repeat of the 1906 San Francisco earthquake today would take 5,000 lives, result in 700,000 injuries and cause $24 billion in property damage. But Federal officials concluded several years ago that planning and preparation for earthquake catastrophes had been inadequate.

Thus the National Earthquake Hazards Reduction Program was formed in 1978 in response to Congressional legislation, and the Bureau was given the responsibility of providing technical support to the building community (including Federal agencies involved in construction) "in continuing the development, testing, and improvement of model seismic design and construction provisions suitable for incorporation in local codes, standards, and practices." The Bureau was also asked to perform "research on performance criteria and supporting measurement technology for earthquake resistant construction."

This NBS research is undertaken in conjunction with work by other Federal agencies, professional organizations, State and local governments, and private industry. One of the first results of this multi-disciplinary effort was the development of tentative provisions to mitigate the impact of earthquakes on buildings. The provisions were prepared by the Applied Technology Council, a group which is associated with the Structural Engineers Associa-

NBS technician Erik Anderson, demonstrates the use of the apparatus that shows how soil liquefaction can topple a building. The process is accelerated by striking the cylinder with a mallet, as shown.

tion of California, under contract with the Bureau. The project was jointly funded by the National Science Foundation and NBS. Tentative seismic design provisions were developed* and are currently under review in a project at NBS by members of the building community. Ultimately, some of the provisions—or modified versions—may be considered for adoption by code and standards organizations and regulatory groups at all governmental levels. Until then, the provisions can provide background information to the building community and help improve earthquake resistant design.

Earthquakes and masonry walls.

In addition to NBS participation in several industry-government interagency projects to develop seismic design standards, major earthquake studies are underway at the Bureau. NBS researchers have conducted tests to measure the seismic resistance of masonry walls. Wall specimens measuring 4 by 6 feet (1.2 by 1.8m) with a thickness of 8 inches (20cm) are subjected to a combination of compression and lateral loads. Lateral shear loads are increased until the wall fails. The wall sections incorporate several types and spacings of steel reinforcement. The researchers will test samples in the future under more complex loadings.

Why masonry? E. V. Leyendecker, leader of the earthquake hazards reduction group, explains that the Bureau has had a long history of conducting masonry research. The research basis for seismic designs of masonry has not been fully developed. Although masonry is relatively inexpensive, fire resistant, and sound absorbent, it is generally considered a poor performer during large earthquakes.

Another major NBS earthquake project is a study of soil liquefaction. This phenomenon occurs when earth shaking makes a soil lose its firmness and begin to flow like a "liquid," sometimes causing buildings atop it to fall (see box).

Soil liquefaction has occurred in seismically active belts around the world, and is part of the Bureau's earthquake hazards reduction program. The research should help builders and engineers determine the soil stability of potential building sites during earthquakes and, in turn, provide them with a better means of assessing the necessary strength of building foundations.

Soil liquefaction, present in at least half of all serious earthquakes—those registering more than 5,5 on the Richter scale—occurs when sand deposits are loose, the water table is high, and an earthquake creates sufficient ground motion. (Though the term soil liquefaction is most often used, much of the research involves the study of sand, with particle sizes smaller than gravel but larger than silt and clay.)

NBS engineer Dr. Riley M. Chung says that research into soil liquefaction is now even more important because of the increased scarcity of suitable land for building. Developers, he explains, are selecting less desirable sites for buildings, which might have been rejected in the past. Many of these areas lie near faults or other geologically active areas.

Past research, Chung says, puts the emphasis on density (weight of sand per unit volume) as the most important factor affecting the response of sand when

*Culver, C., *Tentative Provisions for the Development of Seismic Regulations for Buildings, Nat. Bur. Stand. (U.S.), Spec. Publ. 510, 514 pages (June 1978) Stock No. 003-0038-01939-9, $6.75; from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, (add 25 percent for foreign mailing).*

it is subjected to the periodic vibrations that occur in earthquakes. Other factors, such as the stiffness of the sand (which is affected not only by density, but also by the geometric arrangement of the particles), should be considered, he says.

In one of Chung's experiments, vibrations are included on a small scale in a laboratory instrument known as a resonant column apparatus, which holds a small sample of water-saturated sand. Those tests provide NBS researchers with insights into the sand behavior leading to liquefaction (see box). Another laboratory instrument will be set up at NBS later this year that will allow the testing of specimens subjected to much larger deformations.

On the top floors of New York's World Trade Center, a visitor might have a sensation of moving amid the clouds. That's no illusion. The building actually does sway—perhaps a foot or more during strong gusts.

But it's planned that way. One might wonder: How did the architects figure how much the 110-story tower could sway within safe limits? Maybe the skyscraper should have been made rigid enough that it would move less than an inch (2.5cm) during a 40-mile-an-hour (65 km/h) gust? That cost, however, might be prohibitively high and the rigidity unnecessary or even undesirable.

Building designers, standards writers, and, indirectly, code writers will find questions about construction costs and safety easier to answer as a result of research recently completed under the direction of Dr. Bruce Ellingwood of the NBS Center for Building Technology. Ellingwood and his colleagues have developed an approach for determining suitable structural loads for building design that is far more accurate and rational than any method used in the past. Currently, building codes specify minimum structural requirements according to materials used; different load and resistance factors—allowable stresses—are required for different materials. This diversity has complicated the building design process, especially in designs using a mixture of construction materials.

The new system of probability-based load factors and load combinations developed under Ellingwood's supervision can be used to calculate and specify the structural strength requirements of buildings regardless of the construction materials used. With these load factors and combinations, the reliability of a building to resist structural failure can be judged more easily and with greater accuracy.

The new concept incorporates a design approach called the "probabilistic limit states design"—a design technique allowing the accurate estimation of conditions when a structure fails to achieve its intended purpose in some manner (e.g., collapse, excessive deflection). The designer would then need only to carry out a single analysis, rather than perform a separate load analysis for each material used in a particular structure.

A different kind of motion.

Ellingwood says that future standards (and related codes) that incorporate the new calculation technique would be less likely to lead to overly conservative safety provisions in buildings. Provisions that are inadequate from a safety point of view could also be avoided more easily through use of the new load criterion.

Ellingwood speculates that masonry and wood structures would be affected most by changes resulting from use of the new NBS design calculation technique. He suggests that buildings in which a proportionately high cost lies in the structural system—such as aircraft hangars and industrial buildings—might also be significantly affected in future designs. "Small changes of performance criteria can mean major changes in costs for such buildings," Ellingwood says.

The new load criterion was developed over a 5-year span and utilizes existing field and laboratory data—some of which were developed by NBS. For example, research at NBS involving live and wind loads formed the basis of a portion of the new structural safety tool. The new calculation model is under review by a wide variety of standards-writing groups and design professionals.

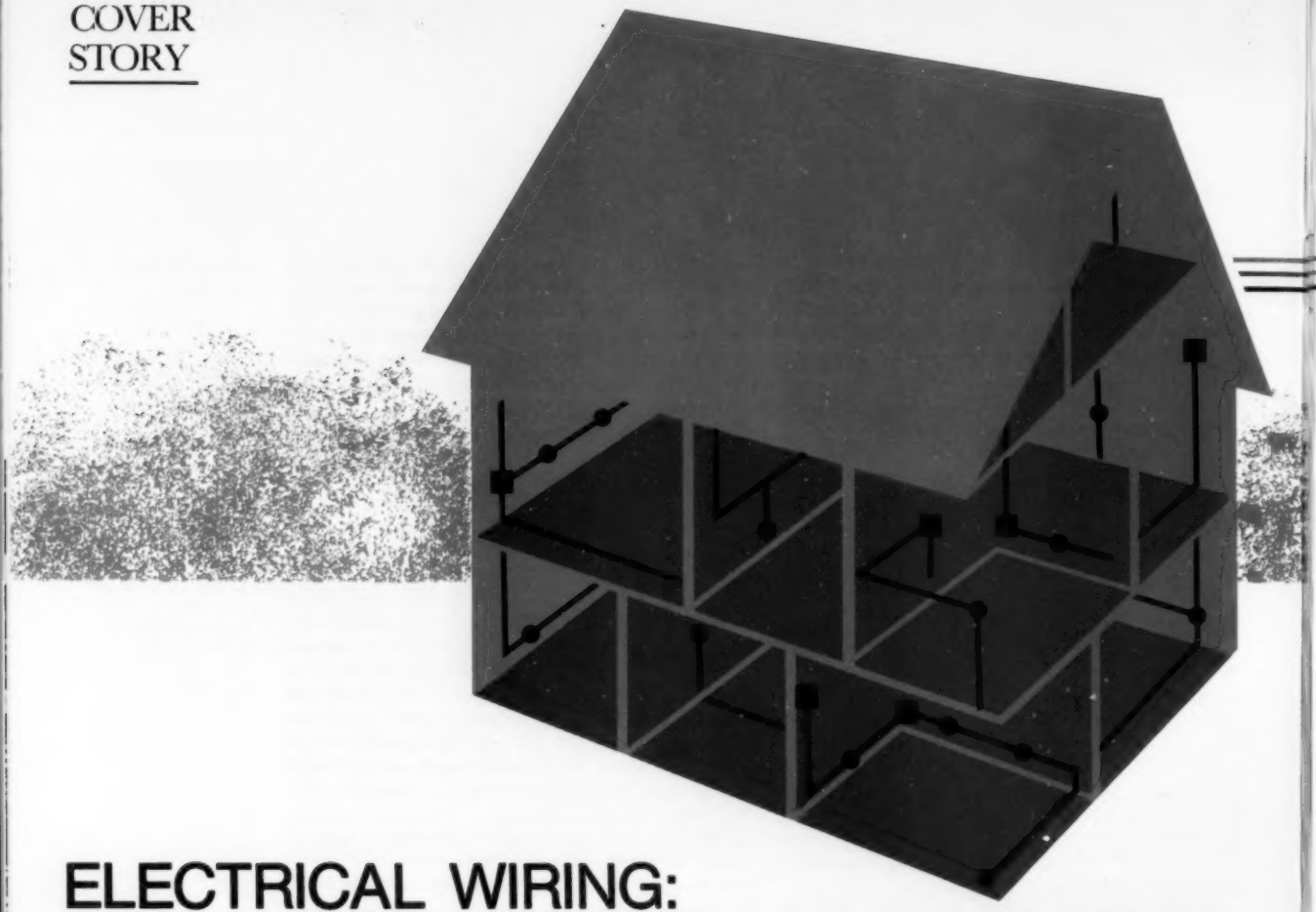
Economic considerations.

Some $7.8 billion damage to buildings is caused annually by natural disasters such as earthquakes, hurricanes, tornadoes, and floods. Losses caused by soil and foundation problems amount to an additional $3.2 billion per year. By the end of the century, unless preventive measures are taken, as marginal lands and exposed coastal areas come under increased development and more buildings are constructed, these losses may double.

Economic losses because of overdesign are difficult to quantify, but may be at least equal to the billions of dollars in annual damages. And, of the $50 billion worth of building materials purchased each year, about 10 percent fail prematurely because of inadequate selection criteria. That results in financial loss and hazardous conditions for building occupants and users.

It is clear that both dollars and lives are at stake in the work being undertaken in the Structures and Materials Division at the NBS Center for Building Technology. □

COVER STORY



ELECTRICAL WIRING: STAYING ON THE SAFE SIDE

by Gail Porter

Like a leviathan circulatory system, electrical wiring connects massive metropolis with tiny hamlet, split-level to mansion, office building to hamburger stand. And like a human circulatory system, electrical wiring is used so continuously and is normally so dependable that most people take it pretty much for granted. . .but they shouldn't.

When used incorrectly or installed improperly, electrical wiring can pose fire and shock hazards. When connections are not made tightly, unneeded power may be drawn if high resistance paths occur. In addition, when the operating temperature for an electrical circuit is high, the increased resistance through the conductor is a source of substantial wasted energy.

Porter is a writer and public information specialist in the NBS Public Information Division.

During the past 10 years, researchers at the National Bureau of Standards (NBS) have undertaken a number of interdisciplinary research projects aimed at improving understanding of how the design, installation, and operation of major wiring components affect the safety and performance of these systems. Their findings can be useful both to research and testing laboratories for improving quality assurance measurements of electrical systems and to consumers interested in "staying on the safe side."

The Quality of Connections

One of the most important factors affecting the safety and performance of electrical wiring systems is the quality of connections made at light fixtures, switches, and receptacles. NBS research has shown that loose connections between electrical wires and the binding screw can cause overheating from high resistance (see box). In laboratory tests, NBS re-

FACTORS AFFECTING WIRING PERFORMANCE

searchers observed loose connections which became so hot that the wire and the screw holding it in place began to glow like the heating element in a toaster. At these kinds of loose connections the glowing conditions pose the possibility that combustible materials near the connection may ignite.

To avoid such problems, NBS researchers suggest that electricians be certain that connections are made securely when they install an electrical system. Care should be exercised when replacing or "stuffing" the receptacle, switch, or fixture back into the electrical junction box. Mechanical stresses from bunched wiring may exert a torque or twisting force that can cause tight connections to loosen over time.

Homeowners should be alert to danger signs of loose connections. Switches or receptacles that are warm to the touch, flickering or dimmed lights, sparking or smoke at receptacles or switches, or the smell or burning plastic or ozone at outlets—*all are clues that it is time to get a qualified electrician to inspect the wiring.*

One way that wiring and wiring component manufacturers are trying to prevent such problems is through the development of improved connections systems which are compatible with wiring of different gages (diameters) or composed of different materials. Traditionally, manufacturers and testing laboratories have judged the relative integrity of different systems by cycling current on and off through a connection and taking temperature measurements. The hotter a connection gets during cycling tests, the more poorly it is expected to perform in actual use.

But temperature measurements, says NBS engineer Owen Laug of the Center for Consumer Product Technology (CCPT), are really only an indirect way of measuring a more important characteristic—electrical resistance. Laug has developed a new experimental measurement system which may provide a more direct means for evaluating the integrity of connections.

Laug's measurement method is based on the fact that electrons moving with a current from one metal surface to another are constricted or funneled through tiny contact points rather than distributed over a wide area. A wire may appear to be in full contact with the binding screw and plate of a plug receptacle, but scanning electron micrographs have shown that electrical contact is made only at sparsely distributed points. Depending on the specific alloy used in a wire and the method and devices used to make a connection, the number of electrical contacts, and thus a factor called constriction resistance, will vary considerably.

To separate constriction resistance from other types of resistance, Laug sends a series of current pulses ranging from 100 to 400 amperes and lasting less than one thousandth of a second through connections being tested. A minicomputer controls the process, triggering the appropriate pulse sequences, measuring the voltage across the connection, and then fitting the resulting data to a mathematical model for calculating the constriction resistance.

While this research is still in the developmental stages, tests have been made of several types of connection devices with both aluminum and copper wires, and the method seems promising. Laug hopes that further testing will allow correlation of this kind of measurement data with estimates of a connection's reliable service life.

Protection Against Overcurrents

Other very important components of any electrical wiring system are the circuit breakers or fuses which protect against excessive currents. Typically, a main utility power line is connected to a home through a service panel containing circuit breakers

Owen Laug checks the quality of a wire nut connection with a computer-operated sequence of electrical pulses and voltage measurements.

Connection Chemistry

When researchers in the Center for Building Technology (CBT) and the Center for Consumer Product Technology (CCPT) discovered that the connections of common household plug receptacles could glow when the connections became loose (see main story), they naturally were curious to know why. What was it about loose connections between perfectly good electrical conductors that caused connections to glow like the heating elements of a toaster?

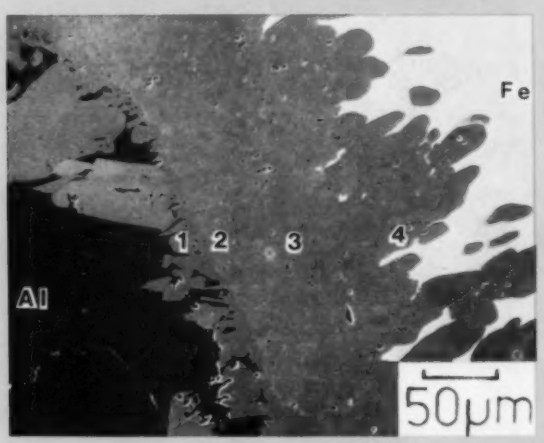
Dale Newbury, a metallurgist in the NBS Center for Analytical Chemistry supplied the answer. In experiments conducted jointly with Sid Greenwald of CCPT, Newbury found that electrical arcing across loose connections of aluminum wiring bound with brass-coated iron screws caused the formation of intermetallic compounds. These are combinations of metals such as Fe_2Al_3, $FeAl_3$ $CuAl_2$ or Cu_9Al_4. Significantly, these intermetallic compounds have electrical resistivities 20 to 200 times higher than those of pure aluminum or pure iron, or about the same magnitude as the nickel-chromium alloy which is used for heating coils, such as those in toasters.

Because previous experiments had shown that this "glow phenomena" occurred when connections became loose, Greenwald first set up a simulation device with aluminum wiring separated just slightly from a brass-coated screw by a spring-loaded arm. With an applied current of 15 amperes, the connection soon began to glow.

Examining both the wire and the screw with a scanning electron microscope, Newbury found that each contained damage "craters." It looked as though electrical arcing had caused aluminum from the wire and brass and iron from the screw to "jump" across the gap between them, leaving erosion craters. Evidence of melted and resolidified iron suggested that temperatures at the crater during this arcing must have been higher than 1500 °C. Using a technique called x-ray microanalysis, Newbury determined that the high temperatures and mixing of metals had formed the intermetallic compound $FeAl_3$.

To confirm that this sequence of events could occur in actual household plug receptacles, a second series of experiments involved cycling current through typical junction boxes until the "glow phenomenon" was observed. Cross-sectional specimens of the screws and wires were then prepared and examined with the optical and electron microscopes, revealing the same kind of impact craters.

More detailed x-ray microanalysis tests, using an NBS-developed analysis procedure called FRAME C for subtracting extraneous background signals from the data and correcting for inter-element effects, clearly showed the presence of the $FeAl_3$ and Fe_2Al_3. Specimens that had been allowed to glow for longer times had greater build-ups of intermetallic material, suggesting that once the process starts, high temperatures keep it going, causing vaporization of metals and rapid reactions.



Scanning electron micrograph close-up reveals a deposit of an intermetallic compound (gray, numbered regions) on a damaged screw.

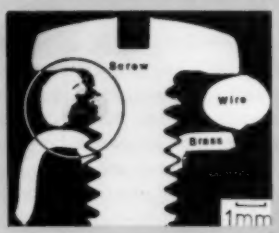
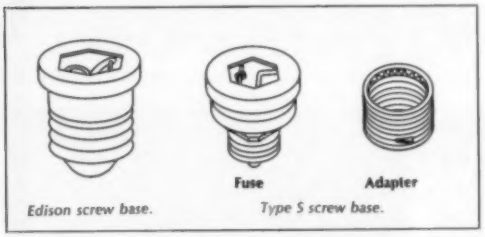


Photo taken with an optical microscope shows a damage region (circled) that developed at a glowing loose connection.

or fuses from which wiring branches out to deliver current throughout the house. Wall plug receptacles and light switches are connected electrically so that current drawn by lamps and other appliances at outlets anywhere along the circuit flows through all connections between those outlets and the main power supply.

If the current drawn at outlets exceeds the rated "safe" amount for a particular house circuit (usually 15 or 20 amperes) then the circuit breaker is designed to "trip" or fuses for that circuit should "blow," disconnecting the circuit from the power supply. The purpose of such protection systems is to avoid dangerous overheating caused by too much current flowing through a wire of particular composition and diameter.

Unfortunately, fuses, especially the older Edison-based type (see diagram), can easily be circumvented by the substitution of a higher rated device than the circuit is designed to use. In a recent 38-home survey of low-income housing conducted by the Community Services Administration, over half of the 216 branch circuits inspected were overfused. Circuits designed for a maximum current of 15 amperes were often found to contain fuses rated for currents as high as 30 amperes.



In older homes, where low-capacity electrical wiring commonly causes fuses to blow when too many appliances are used at once, homeowners occasionally inserted higher ampere fuses to avoid the inconvenience of losing power. Other homeowners have mistakenly replaced a blown fuse with a higher ampere fuse, thinking that it would provide more protection.

Circuit breaker systems may also allow overcurrents under certain conditions. In particular, NBS laboratory research has shown that some circuit breakers can perform poorly at low ambient temperatures. Because most circuit-breaker tripping mechanisms are dependent on heat increases within the device, low ambient temperatures (which may be found in homes where circuit breakers are located in basements, along outside walls, or in external service entry boxes) can cause switches to be slow in reacting to overcurrents. It is anticipated that further research in this area could help in the future design of better circuit breaker systems.

Electrical Wiring and Thermal Insulation

NBS has also been researching the relationship of thermal insulation and residential wiring, a subject that has been raised in recent years as "retrofitting" homes with insulation has become commonplace. During the last 2 years, researchers in the Bureau's Center for Building Technology (CBT) conducted laboratory studies to help judge the effect that adding insulation in walls and attics has

This photo shows the damage caused by placing thermal insulation over the wiring of an overlamped three-bulb lighting fixture. 1) plastic wire connectors have started to melt, 2) electrical insulation has begun to fray 3) the plasterboard simulated ceiling is charred and cracked.

on the temperature of electrical wiring. They found that current-carrying wires sandwiched between two insulation layers will reach temperatures significantly above the 60 °C maximum permitted by the National Electric Code for the type of wiring used in most homes.

Detailed laboratory studies were conducted to simulate actual installations with four different kinds of thermal insulation: ureaformaldehyde foam (UF), loose glass fiber, loose fill cellulose, and loose fill rock wool. Mock-up constructions of a wall and an attic were built with single and multiple lengths of wire sandwiched between insulation as they might be found in some retrofitted homes. With rated currents within the "safe" range, single cables overheated to temperatures as high as 82 °C while multiple wires overheated to 149 °C after one hour. Because the tests were not conducted in a fire laboratory, these experiments were terminated at 149 °C. Higher temperatures may be possible.

Additional research carried out by CCPT researchers has dealt with the effect of thermal insulation covering the wiring of surface-mounted and recessed lighting fixtures. Of particular importance in these studies was the effect of "overlamping," the use of light bulbs of higher wattage than a fixture is designed to use. Higher watt bulbs draw more power, increase the fixture's heat release, and thus raise wiring to higher temperatures. For example, researchers found that when insulation was placed over wiring for a common three-bulb surface-mounted fixture with the correct 60-watt lamping, the wiring overheated to 91 °C. The same test set up with three 150-watt bulbs in the fixture produced temperatures of 170 °C.

While such temperatures may not be high enough to start fires, such overheating may cause degradation of the plastic wire sheathing which protects anyone touching the wire from shock, insulates against current leakage, and prevents short circuits.

Based on the results of these laboratory studies, NBS researchers in CBT recently initiated a field

Robert Beausoliel adjusts the humidity level within test jars in a project to judge the corrosive effect of thermal insulation on electrical connections and junction boxes.

study with a number of utility companies, under the sponsorship of the Department of Energy, to determine the temperatures of electrical wiring surrounded by thermal insulation in actual homes. Participating utility auditors were given about 8000 plastic strips, containing samples of wax indicators that melt at different temperatures, for installation in approximately 2000 volunteer homes. These strips will be returned to NBS after varying periods of time with information on the general electrical conditions found in these homes. Information gathered from the field study will then be correlated with the laboratory data to determine to what extent, if any, wiring sandwiched between insulation poses fire or shock hazards for homeowners.

Meanwhile, in another field study, NBS is working cooperatively with Underwriters Laboratories (UL) to evaluate the overall effects of aging on electrical connections and electrical insulation. According to Tom Faison, leader of the CBT electrical wiring activities, the NBS researchers hope to gather samples of different types of wiring used over the past five decades. These samples will be collected from housing rehabilitation projects across the country and sent to UL and other cooperating testing facilities, where test methods for judging the quality of aged wiring will be developed and the condition of the wiring will be evaluated. It is expected that this study will provide a more realistic estimate of the useful lifetime of each type of wiring system.

All of these studies are designed to improve upon the rather limited bank of scientific literature now available on the safety and performance of residential wiring. Besides the work described, NBS researchers have evaluated many different kinds of innovative electrical wiring systems, developed mathematical models to predict heat build-up in wires covered by thermal insulation, and determined the corrosive effect of thermal insulation on electrical connections and junction boxes in high humidity environments. It is a broad scope of research for a topic with broad application.

Electrical wiring has been around for almost 100 years and it is remarkably dependable considering that well over a billion electrical outlets and other connections are installed throughout the country. Still, even the most reliable of allies should not be taken for granted. □

SOME BASIC ELECTRICAL DON'TS

There are a number of simple steps homeowners can take to minimize electrical wiring hazards. Here are some tips from NBS researchers for staying on the safe side.

- Don't overlamp a lighting fixture by using higher wattage bulbs than that a fixture is designed to use. For example, don't use 100 watt bulbs in a fixture that specifies a maximum of 60 watt bulbs.
- Don't overfuse. Branch circuits should always contain the proper size of fuse. Edison-based fuses should be replaced with S-type fuses which cannot be misused as easily. (See diagram)
- Don't place stacks of newspapers or other highly combustible materials near wall receptacles or switches.
- Don't ignore warning signs of electrical problems—flickering lights, hot wall receptacles and switches, sparking at wall plug receptacles, smoking receptacles, or the smell of burning plastic or ozone at outlets.
- Don't overload plug receptacles with too many appliances.
- Don't try to fix electrical problems yourself—call a qualified electrician.
- Don't use appliances and lights with frayed electrical wires.
- Don't cover recessed or surface-mounted light fixtures with thermal insulation; leave 3 inches of clearance on all sides.

ON LINE WITH INDUSTRY

I-C TEST STRUCTURES FOR RANDOM FAULTS

by Michael Baum

Researchers in the NBS Center for Electronics and Electrical Engineering have completed designs for two new series of random-fault test structures for integrated circuits.

The test structures are especially designed semiconductor devices which are built on semiconductor manufacturing lines, along with regular production devices, to serve as a quality-control check on the manufacturing process. Random-fault test structures include large numbers of identical components which are tested for a variety of physical or electrical faults such as breaks in the circuit or short circuits or incorrect device parameters. The large number of identical structures allows the test results to be analyzed statistically to predict densities of faults in the production devices.

The two new test patterns are designated NBS-16 and NBS-28. NBS-16 is designed for use with CMOS (complementary metal-oxide semiconductor) silicon-on-sapphire processes, a technology that is still somewhat experimental. NBS-16 has been used on a process validation wafer (a wafer containing only test patterns) in a quality-control project for the Air Force Wright Aeronautical Laboratory.

NBS-16, designed by Loren W. Linholm of the NBS Electron Devices Division, includes two different random-fault structures. The first (RF-1) uses four 10 x 10 arrays of MOSFET's (MOS Field-Effect Transistors), similar to those used in I-C memories. Each of the 400 transistors in the RF-1 test structure can be individually addressed and tested for electrical faults.

The second structure (RF-2), still being evaluated, consists of three conducting layers—episilicon, polysilicon, and metal—separated by gate and field oxide, respectively. The episilicon and polysilicon conducting layers are arranged in a criss-cross pattern which simulates the topological features of real CMOS/SOS devices. There are seven subarrays in increasing sizes (57, 114, 225, 375, 750, 1500, and 3000 crossovers), which are meant to be tested for leakage between the different conducting layers.

Test Pattern NBS-28, which is now under evaluation, was designed by Michael A. Mitchell of the NBS Electron Devices Division. NBS-28 (and a modified form, 28A) is similar in concept to the RF-2 structure of NBS-16. The basic structure is a metal interconnect step coverage test, consisting of a serpentine metal line laid criss-cross over polysilicon lines and was designed for an NMOS or PMOS self-aligned silicon gate process. Like the RF-2 design, the step test structure on NBS-28 is divided into nine subarrays of increasing size (150, 330, 480, 960, 2880, 5760, 13400, 28800, and 62400 steps.) Line and space widths on NBS-28 are 8 μm; on 28A the same structures are reduced to line widths of 4 μm, 2 μm, and 1 μm to make the structure more useful in the evaluation of new VLSI technologies. NBS-28A, like NBS-16, also contains a number of discrete test structures. These structures are used to obtain basic process parameters in order to determine if the fabrication steps were performed correctly.

The new test structures reflect the design philosophy of the NBS program on integrated-circuit test structures which, Mitchell points out, emphasizes developing valid methodologies for designing test structures and analyzing the data from them. Particular emphasis is placed on developing fairly sophisticated techniques of statistical analysis of data from the test structures for use in process control.

In NBS-16, for example, the difference between RF-1 and RF-2 is the difference between two different test goals. Automated tests of RF-1 structures yield information on the relative frequency of different types of faults, while tests on RF-2 give information on how the frequency of faults changes as the size of the array increases.

"You get information about which faults occur most frequently," explains Mitchell. "It identifies the places you should look for problems in your process." In a developing technology like SOS, where integrated circuit yield is often low, such information can be crucial.

A good, practical example: working with a commercial manufacturer using a radiation-hardened, silicon-gate CMOS/SOS process, Linholm used data gathered from the random fault structures on process validation wafers carrying NBS-16 to identify a previously unsuspected problem in the wafer fabrication process.

Tapes for controlling the automatic equipment used to make the masks for these test structures are available to interested manufacturers through the Electron Devices Division of the NBS Center for Electronics and Electrical Engineering. Interested parties should contact Michael Mitchell or Loren Linholm, B310 Technology Building, National Bureau of Standards, Washington, DC 20234, or call 301/921-3541.

Baum is a writer and public information specialist in the NBS Public Information Division.

STANDARDSTATUS

TEMPERATURE REFERENCE MATERIALS AVAILABLE

The NBS Office of Standard Reference Materials announces the availability of six reference materials that have been certified by the International Confederation for Thermal Analysis (ICTA) for dynamic measurement of temperature by differential thermal analysis, differential scanning calorimetry, and thermogravimetry. These materials are not intended for use as thermodynamic equilibrium temperature standards.

The clearly discernible and reproducible glass-transition temperature of GM 754 (polystyrene) makes it very useful in polymer science and technology. GM 757 (see table) is a set of special reference materials with well-defined melting points and therefore valuable for studying materials at relatively low temperatures. GM 758, GM 759, and GM 760 are sets of materials for use at successively higher temperatures. GM 761 (see table) is a set of magnetic reference materials for calibrating thermobalances.

The ICTA certificates accompanying these materials describe the test programs in detail, show the variations that arise from both instrument type and heating rate, analyze the causes of the variations, and provide guidelines for the use of these materials under normal operating conditions. The information of differences in heating rate dependence in different instruments is especially important.

Twenty-four laboratories using 8 kinds of apparatus in 4 heating rate ranges were involved in testing GM 754. These tests have shown this polystyrene to be homogeneous and stable. ICTA will continue to monitor it for any instability. Only one test can be made on a sample, because heating above the glass-transition temperature will cause a change in state that may not be reversible on cooling. The quantity of material in each unit is sufficient for more than 100 tests. The GM 754, polystyrene, was selected for its clearly discernible and reproducible glass-transition temperature.

Fourteen laboratories using 10 kinds of apparatus were involved in testing GM 757. These four organic materials exhibit clearly defined melting points at relatively low temperatures. The temperature of a solid-solid phase transition in cyclohexane is also certified.

The 10 materials that make up GM's 758, 759, and 760 comprise eight inorganic salts or oxides that exhibit clearly defined solid-solid phase transitions and include two metals that have sharp melting points. Thirty-four participants supplied data from 22 commercial and 4 custom-built instruments. The certification of these materials serves a useful purpose because ordinary reagent materials may contain different types and amounts of impurities that affect the transition temperatures. In addition, a 4:1 mixture of the SiO_2 and K_2SO_4, which is available in both GM 759 and GM 760, is recommended for evaluating the ability of an instrument to resolve two thermal effects about 10 °C apart.

In most thermobalances, the temperature measured is not that of the sample, but of a fixed point near the sample holder. If a magnet is placed where it can exert an attractive force on a magnetic material in the sample holder, a weight change will occur when the material reaches its magnetic transition temperature. If a magnetic reference material is used, the measured temperature can be corrected. The five materials in GM 761 make the calibration of thermobalances in the 250 °C to 750 °C range possible. Eighteen laboratories using 11 different instrument models were involved in testing GM 761.

The ICTA Certified Reference Materials listed below are available from the Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Washington, DC 20234.

Certified Reference Material	Approx. Temp. (°C)	Wt./Vol.
GM 754		
Polystyrene	105	10 g
GM 757		
1,2-Dichloroethane	− 32	4 mL
Cyclohexane (transition)	− 83	4 mL
(melting)	+ 7	
Phenyl ether	30	4 mL
o-Terphenyl	58	2 g
GM 758		
Potassium nitrate	128	10 g
Indium	157	3 g
Tin	232	3 g
Potassium perchlorate	300	10 g
Silver sulfate	430	3 g
GM 759		
Potassium perchlorate	300	10 g
Silver Sulfate	430	3 g
Silver sulfate	430	3 g
Quartz	573	3 g
Potassium sulfate	583	10 g
Potassium chromate	665	10 g
GM 760		
Quartz	573	3 g
Potassium sulfate	583	10 g
Potassium chromate	665	10 g
Barium carbonate	810	10 g
Strontium carbonate	925	10 g
GM 761		
Permanorm 3	259	1 g
Nickel	353	1 g
Mumetal	381	1 g
Permanorm 5	454	1 g
Trafoperm	750	1 g

STAFF REPORTS

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DEGRADATION OF SOLAR ABSORBER COATINGS

NBS scientists have performed Scanning Electron Microscopy (SEM) studies to assess the degradation of absorptive coatings used in solar energy systems. The studies have identified the processes by which three absorptive coatings degraded when exposed to moisture.

Mildred Post and David B. Ballard, Metallurgy Division, B118 Materials Building, 301/921-3603.*

The oil embargo of 1973 and rapidly escalating oil prices have sparked a marked interest in solar energy. The NBS Center for Building Technology is performing research, sponsored by the U.S. Department of Energy, to aid in developing short-term test methods for predicting the long-term performance of absorptive coatings and other materials used in solar collectors. To give reliable results, it is essential that short-term methods degrade in the same way as in actual service. The primary function of absorptive coatings is to maximize the conversion of solar energy into thermal energy. These methods must be capable of assessing the ability of absorptive coatings to perform under long-term exposure to conditions causing degradation, such as elevated and cyclic temperatures, solar radiation, and moisture.

Three coatings were studied: (A) aliphatic polyurethane topcoat over modified bisphenol type epoxy on zinc phosphate treated steel; (B) polyvinylidene fluoride topcoat over thermo-setting epoxy primer on galvanized steel; and (C) epoxy topcoat over phenolic butyrate primer on anodized aluminum.

By means of standard commercial techniques, coatings A and C were sprayed onto their respective substrates. Panels were air dried, and those with coating C were also subjected to an oven cure at 121 °C for half an hour. Both primer and topcoat of coating B were applied by roller on a commercial coiling line. The primer was baked on in an oven at a metal temperature of 224 °C and the topcoat at a metal temperature of 243 °C. A comparison of physical characteristics of the three coatings is shown in table 1.

All of the absorptive coatings were subjected either to condensing moisture or to high humidity. The three coatings tested were selected for SEM studies because of either reduction in adhesion of the coating to the substrate (as measured by a button pull-test) or degradation of coating and substrate upon exposure to moisture.

For comparison, and to assist in the interpretation of microstructure, both unexposed and exposed substrate panels and coated panels were examined by SEM. Photomicrographs used here provide comparisons of the coated metals, both before and after exposure.

Coating A

A cross-section of an unexposed coated sample is depicted in figure 1. Above the zinc phosphate treatment is a thin, fine granular layer of epoxy primer of variable thickness. Superimposed on this layer is the urethane topcoat.

A photograph of the exposed coated panel surface, from which the coating has been partly removed in the adhesion test, is shown in figure 2. Different surface area characteristics in this photograph and in the schematic (figure 3) are important. The major portion of area 1 examined at higher magnification is still coated with zinc phosphate and an organic coating. There are a few bare steel

*Formerly with the NBS Center for Building Technology.

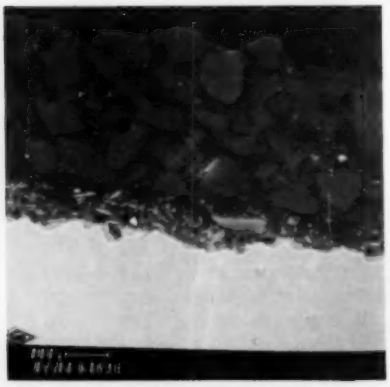


Figure 1—*Cross-section of unexposed urethane topcoat, fine grained epoxy primer, particles of zinc phosphate and steel substrate (reading from top to bottom).*

Figure 2—*Surface of exposed test panel with coating A after adhesion pull-test: Area #1—surface of failed exposed primer and zinc phosphate; Area #2—interface of pull-test epoxy and failed epoxy; Area #3—surface of urethane topcoat; Area #4a—pull-test epoxy under the button; Area #4b—pull-test, epoxy-free surface.*

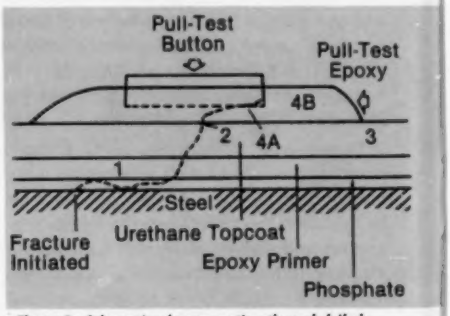


Figure 3—*Schematic of cross-section through failed coating shown in Figure 5.*

surface areas. A cross-section of this exposed stripped area shows separation within the epoxy primer. The layer of zinc phosphate is no longer distinct. In a cross-section of area 2, the epoxy primer is clearly discernible and superimposed on it is the urethane topcoat. The adhesion failure is indicated by the separation which originates in the epoxy primer and extends upward through the topcoat (figure 4).

A comparison of area 3 in figure 2 with the unexposed coating shows that the definite angular shapes and granularity of the carbon particles have mostly disappeared. Some of these particles are apparently removed from the surface after degradation of the vehicle binder.

Conclusions from observations of coating A:

- Prolonged exposure to moisture contributes to the degradation of this coating.
- Loss of adhesion occurs in the epoxy primer with some failure in the zinc phosphate.
- The use of the pull-test results in only partial removal of zinc phosphate and of the coating.
- Exposure to moisture and elevated temperature changes the topography of the urethane topcoat.

Coating B

A photograph of an unexposed coated panel surface shows a slightly pitted appearance. Bright particles embedded in the surface have been investigated by electron microprobe analysis and found to contain a high concentration of zinc. A cross-section of the unexposed sample is pictured in figure 5. The galvanized layer is well defined. Immediately over the galvanized layer is the epoxy primer and above that the polyvinylidene fluoride topcoat.

A cross-section of the exposed coated panel is shown in figure 6. Two changes have evidently occurred. One is the separation between the steel substrate and the galvanized layer (arrow A) and the other is an area of separation between the galvanized surface and the epoxy primer (arrow B).

Conclusions from observations of coating B:

- Exposure to moisture results in degradation of the polyvinylidene fluoride coating, at least at specific sites.
- Failure of the coating may start with absorption of moisture through the holes observed in the coating.
- The moisture penetrates to the galvanized surface, resulting in failure of the interface between the galvanized surface and the substrate.

Coating C

A cross-section of the unexposed epoxy topcoat surface over phenolic butyrate primer is shown in figure 7. The coating is composed of carbon black spheres of varying sizes with the epoxy acting as the binder. Some spheres are partially filled; in others, the interior has a granular appearance. Evidence of the primer is noted by the arrow.

A cross-section of the exposed coated panel is given in figure 8. Not only is there cracking of the binder between the spheres, some of the areas between the spheres have completely disintegrated.

Conclusions from observation of coating C:

- Exposure to moisture results in degradation of the epoxy topcoat.
- This degradation causes debonding from the carbon black particles.
- Moisture penetrates through the cracks in the coating to the metal surface.

This microstructure information on surface topography and cross-section of topcoat, primer, and pretreatment of substrate combinations provided the basis of analysis of the degradation process in these

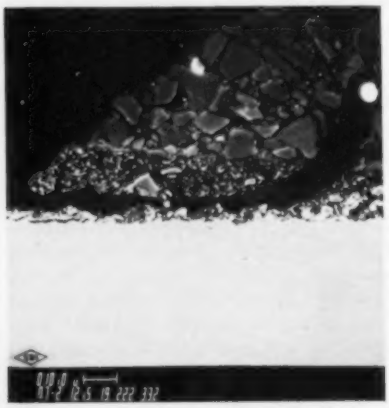


Figure 4—*Cross-section of area #2 (Figure 2 and 3) at the edge of pull-test epoxy and failed epoxy primer.*

Figure 5—*Cross-section of unexposed coating B, (top of bottom) polyvinylidene fluoride topcoat, epoxy primer, galvanized layer, and steel substrate.*

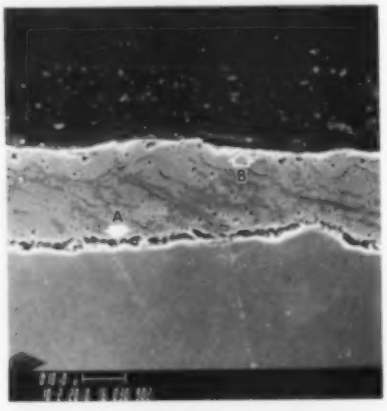


Figure 6—*Cross-section of exposed polyvinylidene fluoride topcoat. Failure is indicated at interface (arrow A) between galvanized layer and steel and interface (arrow B) between galvanized layer and epoxy primer.*

organic coatings. Findings show that moisture is a primary factor affecting the durability of the coatings and that Scanning Electron Microscopy is a valuable tool for studying degradation of solar coatings.

A more detailed account of this research by the same authors appeared in the Journal of Coatings Technology, Vol. 52, No. 664; pp. 55-62 (May 1980).

Figure 7—*Cross-section of unexposed coating C, epoxy topcoat, phenolic butyrate primer on anodized aluminum (top to bottom).*

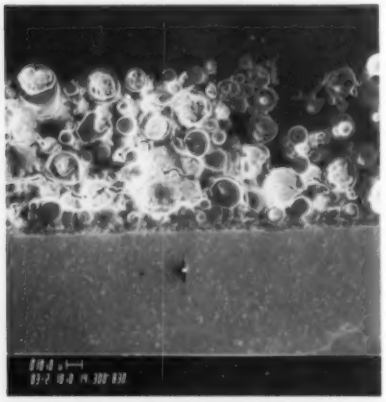


Figure 8—*Cross-section of exposure tested epoxy topcoat. Note partial removal of epoxy coating.*

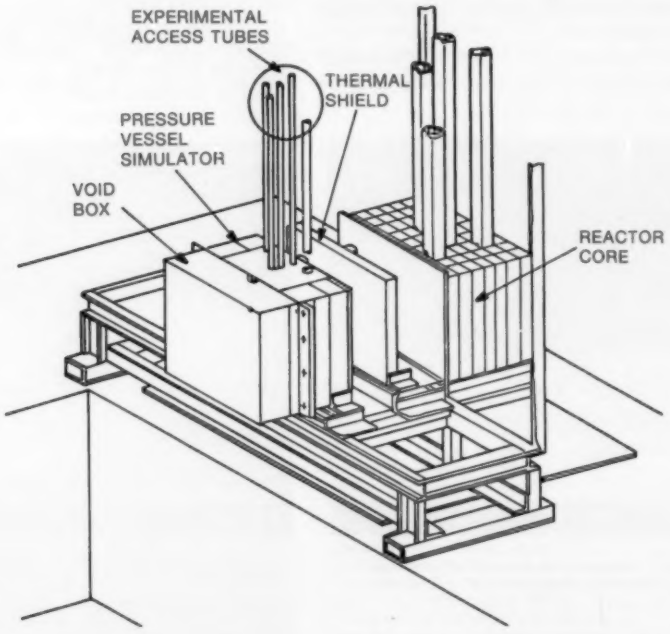
TESTS OF RADIATION EXPOSURE CALCULATIONS FOR REACTOR PRESSURE VESSELS

Standard neutron fields at NBS provide the means for certifying radiation dosimetry measurements made to monitor radiation embrittlement of power reactor pressure vessels. Reproducibility of measurement techniques is verified by interlaboratory comparisons.

E. Dale McGarry, Nuclear Radiation Division, A155 Reactor Building, 301/921–2421.

Comparison of neutron transport calculations to measurements is a necessary test of the nuclear power reactor industry's capability to calculate the neutron exposures of reactor pressure vessels. Such a test is in progress, sponsored by the U.S. Nuclear Regulatory Commission (NRC). The NBS role, which is to certify the neutron exposure measurements, represents the most direct application to date of well-characterized neutron fields at NBS to the calibration of integral neutron sensor techniques. The on-going standardization program includes certified neutron fluence irradiations of dosimetry materials and detectors, as well as measurements with NBS dual fission chambers in a pressure vessel mockup at the Oak Ridge National Laboratory (ORNL).

In May of this year, NBS hosted a forum of U.S. and international representatives of electric utilities and nuclear reactor vendors who were assembled to review comparisons between neutron transport calculations and neutron field measurements. This forum marked the first test of industry's capability to predict neutron exposure of reactor pressure vessels over their expected 40-year lifetime. Validation of the methods of calculation is necessary to predict accurately the transport of neutrons from out-of-



core locations (where surveillance dosimetry and metallurgy specimens are irradiated) to regions within the pressure vessel, where radiation damage occurs but cannot be routinely monitored.

Conclusions from the forum were that most calculations are within 20 percent to 30 percent of measured values, which are accurate to ± 8 percent. This margin of discrepancy between calculation and measurement is a factor of three too large when translated to the cost of shortening the life of a vessel by 30 percent. The large discrepancies are associated primarily with fast-neutron flux intensity rather than spectrum differences. The principal problems arise in the prediction of flux gradients in water near the inner wall of the pressure vessel and in steel near the vessel's outer wall. Investigations are currently under way to resolve the differences.

The pressure vessel mockup in which neutron measurements were made consisted of a simple slab geometry arrangement constructed immediately adjacent to a flat core face of a low-power research reactor at ORNL (see figure 1). Detailed specifications of this mockup, including absolute core-power distributions, were provided to the test participants for calculation of neutron exposure outside of the reactor core and within the pressure vessel wall. Measurements for comparison with these transport calculations included neutron flux-level and core-power measurements performed in the mockup with various types of neutron detectors whose responses were referenced to NBS standard neutron fields. To establish calibration consistency further, selected detectors were calibrated in the standard uranium-235 neutron fields at both NBS and at the Belgian National Center for Nuclear Studies (CEN/SCK) at Mol, Belgium. For both of these fields, the total flux intensity is referenced to the known source strength of a small, but intense, spontaneous fission neutron source of californium-252 at NBS. This source is the primary neutron intensity standard for the NRC surveillance program and is shown in the left photograph of figure 2, located between two NBS fission chambers positioned for calibration.

Figure 1. *Schematic of the low-power, reactor pressure vessel mockup. Neutron fields in this mockup are characterized by a variety of accurate neutron dosimetry measurements to serve the NRC as a calculational benchmark for reactor neutron transport computations.*

NBS Standard Neutron Irradiation Facilities

Pressurized Water Reactor Vessels

Calibration

$$\frac{\text{Known Fluence}}{\text{Measured Fission Rate}} = \frac{\text{Unknown PWR Fluence}}{\text{Measured Fission Rate}}$$

Surveillance

Figure 2. *LWR Pressure Vessel Irradiation Surveillance Dosimetry.*

The detector responses that were calibrated in the NBS and CEN/SCK benchmark neutron fields were found to be in agreement to within 1.5 percent. The agreement reflects the long-term consistency and precision with which these two laboratories perform such measurements.

The NRC Division of Reactor Safety Research initiated the Light Water Reactor Pressure Vessel Surveillance Dosimetry Improvement Program to accomplish the goals summarized in table 1. Results from this program will establish improved procedures for the prediction and verification of changes in steel fracture toughness because of neutron induced embrittlement during the service life of a pressure vessel.

Table 1. The NRC Nuclear Reactor Pressure Vessel Surveillance Program

1. Establish an appropriate surveillance program for each operating power plant.
2. Develop reactor-physics computational tools necessary to support the surveillance requirements.
3. Develop ways to relate neutron dosimetry, metallurgy and temperature data from the surveillance activities to all current and future pressure vessel conditions.

CONFERENCES

For general information on NBS conferences, contact JoAnn Lorden, NBS Public Information Division, Washington, DC 20234, 301/921-2721.

PULSE POWER MEASUREMENTS WORKSHOP

The Commerce Department's National Bureau of Standards will hold a special workshop on the Measurement of Electrical Quantities in Pulse Power Systems at the NBS Laboratories in Boulder, Colorado from March 2 to 4, 1981.

The workshop is intended to disseminate state-of-the-art measurement techniques for dealing with short, high-powered electrical pulses. Particular attention will be paid to pulse systems with a pulse duration less than one millisecond and system voltages and currents greater than 10 kilovolts and 10 kiloamperes.

Such pulses are of interest in the design of high-powered lasers and certain types of inertial and magnetic confinement fusion systems, in charged particle beam technology, in electromagnetic pulse research, and as transients in electric power systems.

Technical topics at the workshop will include voltage measurements, current measurements, power and energy, and data acquisition and processing. A $15 registration fee will be charged.

Those interested in attending the workshop should register with Sandra B. Kelley, B344 Metrology Building, NBS, Washington, DC 20234.

NATIONAL ROOFING CONTRACTORS ASSOCIATION SYMPOSIUM

"Performance and Durability of Roofing Systems" will be the theme of the 6th Conference on Roofing Technology, to be held April 30-May 1, 1981, at the Gaithersburg, Maryland, headquarters of the National Bureau of Standards. NBS and the National Roofing Contractors Association (NRCA) are cosponsors of the conference, as they have been from the inception of the binannual symposia series in 1969.

The opening day (April 30) sessions will be devoted to current roofing research and built-up roofing practices.

William Cullen of NBS will open the conference, and welcoming remarks will be delivered by NRCA President William Kugler, NBS Director Ernest Ambler, and General Conference Chairman George Bodwell. Sessions will be chaired successively by Ray Johnson of the Empire Roofing Co., Robert Mathey of NBS, and Richard Snyder of the Asphalt Roofing Manufacturers Association.

To promote discussion and idea exchanges and because of space limitations, attendance will be held to the first 300 registrants. The registration fee is $100.

For further details contact William Good, NRCA, 301/383-9513 or Robert Mathey, NBS, 301/921-2629.

20TH ACM/NBS SYMPOSIUM

Papers are now being solicited for the 20th Annual Technical Symposium sponsored by the Association for Computing Machinery's Washington, DC, Chapter and the National Bureau of Standards. "Crisis in Computing: Innovation in a Constrained Environment" is the theme of the June 18, 1981, symposium, which will be held at the University of Maryland's Center for Adult Education in College Park, Maryland.

Dr. Charles W. Bridges, Navy Regional Data Automation Center, is serving as general chair of the symposium. The program chair is James J. Pottmyer, Defense Communications Agency.

According to symposium officials, innovation in automatic data processing is constrained by scarcity of resources, laws and regulations, contractual requirements, human shortcomings in managing complex systems, needs for security, intractability of some computing problems, and computer industry economics. Papers with an empirical and practical basis are particularly encouraged to complement theoretical papers which will also be presented at the symposium. Related problems to be addressed, in keeping with the conference theme, include tools for innovation, protecting existing investment, and particular needs for innovation.

Authors should submit five double-spaced manuscripts (unpublished papers only) by January 13, 1981, to the program vice-chair, Wilma M. Osborne, B265 Technology Building, NBS, Washington, DC 20234.

Brief (400-word) summaries on current research will also be considered. Notification of action on submissions will be sent to authors by March 6. About 20 minutes will be allowed at the symposium for presentation of full-length papers; 10 minutes will be allotted for current research summaries.

For further information contact Wilma M. Osborne, B265 Technology Building, NBS, 301/921-3485.

COMPUTER SECURITY INITIATIVE SEMINAR

The Department of Defense Computer Security Initiative Program, third in a series of seminars, will be held November 18-20, 1980, at NBS, Gaithersburg, MD. This is to acquaint computer system developers and users with the status of "trusted"* ADP system developments within the Department of Defense and current planning for the integrity evaluation of commercial implementations of similar systems. The two previous seminars have stressed user requirements for trusted computer systems within both the Government and the private sector.

The first day of this seminar will include presentations by several computer manufacturers of the trusted system development activities within their organizations. Following these presentations there will be a panel discussion on "How can the Government and the computer industry solve the computer security problem?"

The second day of the seminar will include discussion of the technical evaluation criteria proposed as a basis for determining the relative merits of computer

**A "trusted" ADP system is one which employs sufficient hardware and software integrity measures to allow its use for simultaneously processing multiple levels of classified and/or sensitive information.*

systems. The introduction to formal specification and verification technology that follows will include descriptions of the basic types of formal specification and the implications of design and program verification. Representatives of several prominent specification and verification research groups will discuss their systems.

The third day's program will open with a discussion of software testing techniques, emphasizing the role of such testing in revealing errors that present-day verification cannot detect. A discussion by the developers of the DOD-sponsored Trusted Systems will follow, concerning techniques used to assure a quality product. The Seminar will conclude with a panel discussion on "Where should you put your assurance dollars?"

For further general information contact Dennis K. Branstad, A255 Technology Building, NBS, 301/921-3861.

CONFERENCE CALENDAR

***November 6-7**

MOISTURE MEASUREMENT AND CONTROL FOR SEMICONDUCTOR DEVICES, NBS, Gaithersburg, MD; sponsored by NBS and Rome Air Development Center, USAF; contact: W. Murray Bullis, A353 Technology Building, 301/921-3516.

November 18-20

THIRD SEMINAR ON THE DEPARTMENT OF DEFENSE COMPUTER SECURITY INITIATIVE PROGRAM, NBS, Gaithersburg, MD; sponsored by NBS and DOD; contact: Dennis K. Branstad, A255 Technology Building, 301/921-3861.

December 10

COMPUTER NETWORKING SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and IEEE; contact: Robert Toense, B226 Technology Building, 301/921-3516.

1981

***March 2-4**

MEASUREMENT OF ELECTRICAL QUANTITIES IN PULSE POWER SYSTEMS, NBS, Boulder, CO; sponsored by NBS; contact: Ronald McKnight, B344 Metrology Building, 301/921-3121.

March 17-18

SECOND CONFERENCE ON CONSUMER PRODUCT STANDARDS, NBS, Gaithersburg, MD; sponsored by NBS and ASTM; contact: Walter Leight, 111 EM Building, 301/921-3750.

***March 23-24**

ADP SECURITY AND AUDITING, NBS, Gaithersburg, MD; sponsored by NBS and Federal ADP Users Group; contact: T. C. Lowe, A265 Technology Building, 301/921-2750.

April 6-10

6TH INTERNATIONAL SYMPOSIUM ON NOISE IN PHYSICAL SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS and the Catholic University of America; contact: Robert J. Soulen, B128 Physics Building, 301/921-2018.

April 30-May 1

NATIONAL ROOFING TECHNOLOGY CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS and NCRA; contact: Robert Mathey, B348 Building Research Building, 301/921-2629.

June 1-3

6TH INTERNATIONAL SYMPOSIUM ON IMAGING AND ULTRASONIC TISSUE CHARACTERISTICS, NBS, Gaithersburg, MD; sponsored by NBS, NIH, IEEE, and AIUM; contact Mel Linzer, A366 Materials Building, 301/921-2611.

June 8-12

SECOND INTERNATIONAL CONFERENCE ON PRECISION MEASUREMENTS AND FUNDAMENTAL CONSTANTS, NBS, Gaithersburg, MD; sponsored by NBS, IUPAP, and AMCO; contact: Barry N. Taylor, B258 Metrology Building, 301/921-2701.

June 15-19

INTERNATIONAL JOINT CONFERENCE ON THERMOPHYSICAL PROPERTIES, NBS, Gaithersburg, MD; sponsored by NBS, ASME, and Purdue University; contact: A. Cezairliyan, Room 124 Hazards Building, 301/921-3687.

***June 18**

20TH ANNUAL ACM SYMPOSIUM, UNIVERSITY OF MARYLAND, College Park, MD; sponsored by NBS and ACM; contact: Wilma Osborne, A265 Technology Building, 301/921–3485.

September 14-16

SECOND INTERNATIONAL CONFERENCE ON THE DURABILITY OF BUILDING MATERIALS AND COMPONENTS, NBS, Gaithersburg, MD; sponsored by NBS, ASTM, NRC of Canada, International Council for Building Research Studies and Documentation, International Union of Testing and Research Laboratories for Materials and Structures; contact: Geoffrey Frohnsdorff, B348 Technology Building, 301/921-3458.

***October 7-9**

36TH CALORIMETRY CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS and University of Colorado; contact: Robert Goldberg, A303 Physics Building, 301/921-2752.

***October 13-15**

6TH ANNUAL CONFERENCE ON MATERIALS FOR COAL CONVERSION AND UTILIZATION, NBS, Gaithersburg, MD; sponsored by NBS, DOE, EPRI, and GRI; contact: Samuel Schneider, B308 Materials Building, 301/921-2894.

**New Listings*

PUBLICATIONS

ACCURACY IN POWDER DIFFRACTION PROCEEDINGS

Block, S., Hubbard, C. R., Accuracy in Powder Diffraction, Nat. Bur. Stand. (U.S.), Spec. Publ. 567, 553 pages (Feb. 1980) Stock No. 003-003-02153-9, $9.

The National Bureau of Standards has recently released the proceedings of a 1979 symposium on Accuracy in Powder Diffraction. The week-long symposium, held at the Bureau's headquarters in Gaithersburg, Md., focused on recent trends in powder diffraction techniques and applications.

The NBS publication, *Accuracy in Powder Diffraction* (SP 567), highlights the increased interest that scientists have shown in the last two decades to obtain precise measurements and analyses in powder diffraction. Since the last international meeting in 1959 on powder diffraction, there have been major developments in materials science. At the same time, there has been a renewed and enlarged interest in powder diffraction to analyze and characterize materials. The applications for powder diffraction range from stress determination to quantitative analysis and structural determination from line shape.

Furthermore, new experimental developments, including synchrotron radiation and improved detectors, have opened new possibilities for powder diffraction; advances in theory and computing ability have improved the analysis of patterns, and more and more use is being made of powder diffraction techniques now that microprocessors are available at reasonable prices. Moreover, scientists have begun to realize the utility of powder diffraction for analyzing toxic pollutants.

To provide an overview of these trends, techniques, and applications, *Accuracy in Powder Diffraction* contains most of the invited talks, extended abstracts or papers from selected contributions, and abstracts of all remaining papers. This NBS publication should therefore serve not only as a record of the symposium, but as a source book for the latest knowledge in the field of powder diffraction.

The symposium was cosponsored by the International Union of Crystallography, the National Research Council of Canada, and NBS. The major topics of the symposium, as they appear in the NBS publication, were Total Pattern, Instrumentation and Automation, Profile Fitting, Analysis of Peak Shape, Lattice Parameters and Indexing, Applications, and Future Opportunities in Powder Diffraction.

BUILDING REGULATORY TRENDS ASSESSED

Berry S. A., Ed., Research and Innovation in the Regulatory Process, Nat. Bur. Stand. (U.S.), Spec. Publ. 586, 261 pages (June 1980) Stock No. 003-003-02212-8, $7.

A wide-ranging exchange of views among building code and industry experts from around the country is represented in *Research and Innovation in the Building Regulatory Process*, a new publication of the National Bureau of Standards.

Some 20 talks, papers, and reports are included in the 261-page volume embodying the proceedings of the Fourth NBS/NCSBCS Joint Research Conference held in St. Louis in conjunction with the 12th annual meeting of the National Conference of States on Building Codes and Standards (NCSBCS). Included among topics covered are:

- Issues in building code enforcement
- Legal, political, and educational aspects of code enforcement
- Housing code studies
- Energy conservation and the built environment
- Design considerations and their impact on code enforcement
- Innovative regulatory approaches for metrication, insulation standards, and climatic conditions.

COMPREHENSIVE ENERGY DESIGN ECONOMICS

Marshall, H. E., and Ruegg, R. T., Simplified Energy Design Economics: Principles Applied to Energy Conservation and Solar Investments in Buildings, Nat. Bur. Stand. (U.S.), Spec. Publ. 544, 54 pages (Jan. 1980) Stock No. 003-003-02156-3, $3.50.

A comprehensive guide to basic economic concepts and tools for making decisions about energy conservation and solar energy investments in buildings has been prepared by economists Dr. Harold E. Marshall and Rosalie T. Ruegg of the Center for Building Technology at the National Bureau of Standards.

Energy Conservation in Buildings: A Guidebook for Investment Decisions (HB 132) is the "parent" guide from which a popularized version, *Simplified Energy Design Economics* (SP 544), was extracted.

The 149-page larger handbook gives special attention to solar energy investments and includes extensive problem sets. It should assist architects, builders, engineers, and others to solve fairly sophisticated design problems. The authors suggest that the guide will also provide analysts outside of the design profession with ways to evaluate energy conservation investment problems.

Five tools of economic analysis are explained: life-cycle costs, net benefits, savings-to-investment ratio, internal rate of return, and discounted payback. Their advantages and disadvantages are discussed, and guidelines are given for selecting the appropriate method for dealing with specific types of investment problems.

Factors affecting benefits and costs—such as time horizons, discount rates, inflation, and taxes—are presented. Dis-

Publications cited here may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (foreign: add 25 percent). Microfiche copies are available from the National Technical Information Service, Springfield, VA 22161. For complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, DC 20234.

counting, the technique for assessing the time value of money, is explained and illustrated in a problem analyzing the economics of heat pumps. Detailed case illustrations for solar heating and window design (not included in the simplified edition) are also described. A glossary of economic terms, discount formulas, and tables of compound interest are included in the handbook.

NML RESEARCH HIGHLIGHTS FOR 1979

National Measurement Laboratory Technical Highlights for 1979, Nat. Bur. Stand. (U.S.), Spec. Publ. 572, 126 pages (April 1980), Stock No. 003-003-02203-7, $4.25.

The National Measurement Laboratory (NML), the physical science research arm of the National Bureau of Standards, has published a detailed description of over forty significant research events at the Laboratory for 1979.

The review, published as *National Measurement Laboratory 1979 Technical Highlights*, covers the broad range of NML research interests pursued in five research centers and seven special cross-discipline offices for measurement services, non-destructive evaluation, environmental measurements, standard reference materials, standard reference data, nuclear technology measurements, and recycled materials. NML conducts research in the fields of physics, chemistry, and materials sciences for the Bureau of Standards.

A typical sampling of projects reported in the Technical Highlights includes:

- an experiment to improve time and frequency standards by "cooling" atomic ions with laser radiation to reduce their thermal motion, the dominant cause of measurement uncertainty in the present standards.
- "surface science" research into the key catalytic processes used to create synthetic methane ("natural gas") from coal.
- an application of radiocarbon dating (carbon-14 analysis) to certain important atmospheric pollutants to determine how much of the pollution is the result of natural processes in the environment and how much the result of burning fossil fuels. Such results are important in modeling the effect of man on the environment and devising suitable regulations where necessary.
- a study of the electrical signals generated by the electrochemical process of corrosion of iron and aluminum, work which may lead to an electrical method for detecting incidents of pitting corrosion in important engineering systems.

Each research highlight, written by the scientists responsible for the work, is illustrated with appropriate graphs and diagrams.

PUBLICATIONS LISTING

Building Technology

Clifton, J. R., Stone Consolidating Materials—A Status Report, Nat. Bur. Stand. (U.S.), Tech. Note 1118, 52 pages (May 1980) Stock No. 003-003-02191-1, $3.50.

Frohnsdorff, G., Masters, L. W., and Martin, J. W., An Approach to Improved Durability Tests for Building Materials and Components, Nat. Bur. Stand. (U.S.), Tech. Note 1120, 35 pages (July 1980) Stock No. 003-003-02213-6, $2.25.

Computer Science and Technology

Varner, R. N., and Raybold, R. C., National Bureau of Standards Mass Calibration Computer Software, Nat. Bur. Stand. (U.S.), Tech. Note 1127, 164 pages (July 1980) Stock No. 003-003-02209-8, $5.

Electronic Technology

Duffy, M. T., Zanzucchi, P. J., Ham, W. E., Corboy, J. F., and Cullen, G. W., Semiconductor Measurement Technology: Method to Determine the Quality of Sapphire, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-62, 74 pages (Aug. 1980) Stock No. 003-003-02222-5, $4.

Bullis, W. M., Ed., Semiconductor Measurement Technology: April 1, 1977 to September 30, 1977, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-45, 43 pages (Aug. 1980) Stock No. 003-003-02220-9, $2.25.

Failure Analysis

Fong, J. T., Dobbyn, R. C., and Mordfin, L., Eds., Critical Materials and Fabrication Issues for Pressure Vessels, Piping, Pumps, and Valves. Preview of an ASME Symposium cosponsored by the National Bureau of Standards, held at the St. Frances Hotel, San Francisco, CA, Aug. 14-15, 1980, Nat. Bur. Stand. (U.S.), Spec. Publ. 588, 112 pages (June 1980) Stock No. 003-003-02215-2, $4.25.

Fire Research

Levin, B. M., Ed., Fire and Life Safety for the Handicapped. Report of the Conference on Fire Safety for the Handicapped held at the National Bureau of Standards, Nov. 26-29, 1979, Nat. Bur. Stand. (U.S.), Spec. Publ. 585, 154 pages (July 1980) Stock No. 003-003-02210-1, $5.

Mulholland, G. W., and Liu, B. Y. H., Response of Smoke Detectors to Monodispersed Aerosols, J. Res. Nat. Bur. Stand. (U.S.), 85, No. 3, 223-238 (May-June 1980).

Sensenig, D. L., An Oxygen Consumption Technique for Determining the Contribution of Interior Wall Finishes to Room Fires, Nat. Bur. Stand. (U.S.), Tech. Note 1128, 87 pages (July 1980) Stock No. 003-003-02211-0, $3.75.

Instrumentation and Experimental Methods

Shideler, R. W., and Bertocci, U., A Low-Noise Potentiostat for the Study of Small Amplitude Signals in Electrochemistry, J. Res. Nat. Bur. Stand. (U.S.), 85, No. 3, 211-217 (May-June 1980).

Measurement Science and Technology Physical Standards and Fundamental Constants

Bower, V. E., Davis, R. S., The Electrochemical Equivalent of Pure Silver—A Value of the Faraday, J. Res. Nat. Bur. Stand. (U.S.), 85, No. 3. 175-191 (May-June 1980).

Metrology: Physics and Radiation Technology

Eckerle, K. L., Photometry and Colorimetry of Retroreflection: State-of-Measurement-Accuracy Report, Nat. Bur. Stand. (U.S.), Tech. Note 1125, 44 pages (July 1980) Stock No. 003-003-02208-0, $2.25.

Jones, F. E., Schoonover, R. M., Houser, J. F., In-Tank Measurement of Solution Density, J. Res. Nat. Bur. Stand. (U.S.), 85, No. 3, 219-221 (May-June 1980).

Properties of Materials: Structural and Mechanical

Hubbard, C. R., Mighell, A. D., and Fatiadi, A. J., Dixanthylurea (N, N'-di-Xanthen-9-ylurea), J. Res. Nat. Bur. Stand. (U.S.), 85, No. 3, 205-210 (May-June 1980).

Standard Reference Materials

Velapoldi, R. A., Paule, R. C., Schaffer, R., Mandel, J., Machlan, L. A. Garner, E. L., and Rains, T. C., Standard Reference Materials: A Reference Method for the Determination of Lithium in Serum, Nat. Bur. Stand. (U.S.), Spec. Publ. 260-69, 114 pages (July 1980) Stock No. 003-003-02214-4, $4.25.

Thermodynamics and Chemical Kinetics

Prosen, E. J., and Colbert, J. C., A Microcalorimeter for Measuring Self-Discharge of Pacemakers and Pacemaker Power Cells, J. Res. Nat. Bur. Stand. (U.S.), 85, No. 3, 193-203 (May-June 1980).

Other Subjects of General Interest

Rubin, A. I., Ed., Lighting Issues in the 1980's. Summary and Proceedings of a Lighting Roundtable held at the Sheraton Center, New York, NY, June 14-15, 1979, Nat. Bur. Stand. (U.S.), Spec. Publ. 587, 175 pages (July 1980) Stock No. 003-003-02218-7, $5.50.

NEWS BRIEFS

PIEZOELECTRIC POLYMER HYDROPHONE PROBE. Researchers from NBS and the Food and Drug Administration have developed an acoustically "transparent" hydrophone probe using a piezoelectric polymer as the active element. The probe can be used to calibrate ultrasound instruments used in medical applications and to locate potentially dangerous high intensity spots in the ultrasonic field. Unlike conventional ceramic probes which unavoidably alter the acoustic field, the piezoelectric polymer in this invention has an excellent mechanical impedance match to water and therefore minimizes distortion of the sonic field being measured.

TESTS OF AIR LEAKAGE IN MOBILE HOMES. Researchers in the NBS Center for Building Technology have completed a series of tests of the air leakage characteristics of mobile homes. There are few existing measurements of this type, even though such information is important for predicting energy use and indoor air pollutant concentrations and their health effects. The NBS tests, conducted in one of the Bureau's seven "environmental chambers," are part of an ongoing study of the thermal characteristics of mobile homes. Infiltration rate was measured by tracer gas, and envelope permeability was determined by fan depressurization. A report is available.

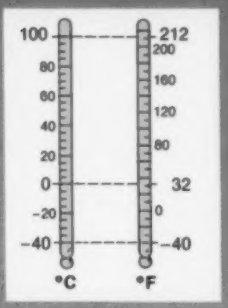
POROUS IMPLANT MATERIALS. In response to a request from the Food and Drug Administration's Bureau of Medical Devices, NBS scientists are determining the reliability of methods for characterizing porous polymer implant materials. These materials are gaining widespread use as replacements for hard tissues which have been surgically removed. Because they are porous and compatible with the body, the polymers allow the patient's tissue to grow into them, thereby replacing the excised part with a composite of natural and synthetic material. NBS researchers will be evaluating the accuracy and reproducibility of methods currently used by manufacturers to produce and characterize pore size.

WEIGHTS AND MEASURES QUALITY CONTROL PROGRAM. The NBS Office of Weights and Measures has completed the first phase of a comprehensive mass measurement control program with State weights and measures laboratories. The goal of the program is to provide a means to verify and document the validity of day-to-day mass calibrations performed by the State laboratories and to correlate these measurements with those made at NBS. Most State standards continue to agree with original NBS calibrated values. In a few cases recalibration by NBS may be necessary.

PROPOSALS FOR 1982 PRECISION MEASUREMENT GRANTS. NBS is requesting proposals for two research grants in the fields of precision measurement and determination of fundamental constants. The 1-year grants are valued at $30,000 each and may be renewed by NBS for up to 2 additional years. These grants have been awarded each year since 1970 to scientists in academic institutions for work in determining values for fundamental constants, investigating related physical phenomena, or developing new methods and instruments for making very precise measurements of physical quantities. Summaries of proposed projects and biographical information must be submitted by February 15, 1981, to Dr. Barry Taylor, B258 Metrology Building, Washington, DC 20234.

NEXT MONTH IN

DIMENSIONS/NBS



You know what a thermometer is—or do you? Perhaps a feature in the November DIMENSIONS/NBS will introduce you to some new concepts in the field of thermometry.

U.S. DEPARTMENT OF COMMERCE
Philip M. Klutznick, Secretary

Jordan J. Baruch, Assistant Secretary for Productivity, Technology and Innovation

NATIONAL BUREAU OF STANDARDS
Ernest Ambler, Director

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Mark Helfer: pages 9, 13 and 16.

Beamie Young: page 10.

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